EXECUTED AND IMAGINED GRASPING MOVEMENTS CAN BE DECODED FROM LOW DIMENSIONAL REPRESENTATION OF DISTRIBUTED BRAIN-WIDE NEURAL RECORDINGS.

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Abstract
Many people worldwide have lost part of their autonomy due to physical impairments. Increasing autonomy again can be achieved by the direct use of brain-activity as control signal of assistive tools. Accessing the users intention directly from the neural activity might provide the most natural way of control for their assistive tool. To achieve this, one needs to capture rich movement related neural activity, thus the primary motor cortex is often targeted. Unsurprisingly, state-of-the-art decoders use invasive microelectrode arrays in specific motor areas such as the hand knob area. While these areas are the basis of high-performing decoders, these superficial and spatially local areas do not capture the full extent of the motor control network. Therefore, efforts in this work focus on capturing the neural signal from other brain areas, including deeper structures. We explored the informational content of distributed brain-wide invasive neural recordings in humans by extracting a lower dimensional representation. Subsequently, a movement decoder is trained on this representation to assess the movement related informational content. 13 epilepsy participants with implanted depth electrodes performed 60 trials of executed and imagined movements. We extracted the beta and high-gamma frequency bands, transformed the data to 3 to 50 principal components and decoded the components using a Riemannian decoder by trial-wise 10-fold cross validation. The decoder reached significantly above chance performance for nearly all frequency band combinations and number of principle components. Averaging an area under the curve of 0.75 $\pm$ 0.13 for executed movements and 0.63 $\pm$ 0.10 for imagined movements. The maximum performance was reached of 0.82 $\pm$ 0.11 with 45 components from beta and high gamma activity in executed movements. Overall performance increased with the amount of components included, stabilizing at 20 to 30 components. The results show that executed and imagined movements can be decoded from distributed brain-wide recordings, without necessarily including the motor cortex. Compared with other brain-area specific decoding works, our methodology might also capture network effects.